University of Kota, Kota

M.Sc (F)- Botany

Examination – 2013

Scheme of Examination

There will be six papers, four compulsory and two elective, in theory of 3 hours duration carrying 100 marks each and two practical such as follows :

1. Practical for compulsory papers of 200 marks of 8 hours duration to be completed in two days.
2. Practical for elective papers – 100 marks of 4 hours duration to be completed in one day.

Each theory paper will have 15 questions, out of which a student has to attempt 8 questions and the question No.1 will be compulsory. The question No.-1 will carry 10 marks and will be of several short objective type of questions such as multiple choice type, one line answer type, one word type, fill in the blanks type.

Paper VII	Plant Development & Reproduction
Paper VIII	Cell and Molecular Biology of Plant
Paper IX	Plant Resource Utilization & Conservation
Paper X	Biotechnology & Genetic Engineering, Plant Breeding & Biometry
Paper XI (a)	Advanced Plant Pathology – I
Paper XII (a)	Advanced Plant Pathology – II
Paper XI (b)	Environmental Biology – I
Paper XII (b)	Arid Zone Ecology – II

M.Sc. (F) Botany Examination- 2013

Paper VII : Plant Development and Reproduction

Scheme of Examination **Duration : 3 hours** **Max. Marks : 100**

Note : The question paper will contain three sections as under –

Section A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total Marks : 10

Section B : 10 question, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total Marks : 50

Section C : 4 questions (question may have sub division) covering all units descriptive type, answer in about 500 words,2 questions to be attempted. Total Marks : 40

UNIT – I

Introduction : Unique features of plant development, differences between animal and plant development.

Seed germination and seedling growth : Metabolism of nucleic acids, proteins and mobilization of food reserves, tropisms, hormonal control of seedling growth, gene expression, use of mutants in understanding seedling development.

UNIT – II

Root development : Organization of root apical meristem (RAM), cell fates and lineages, vascular tissue differentiation, lateral roots, root hairs, root-microbe interactions.

Shoot development : Organization of the shoot apical meristem (SAM), cytological and molecular analysis of SAM, control of cell division and cell to cell communication, control of tissue differentiation, especially xylem and phloem, secretory ducts and laticifers, wood development in relation to environmental factors.

Leaf growth and differentiation : Determination, phyllotaxy, control of leaf form, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.

UNIT – III

Reproduction : Vegetative and sexual reproduction, flower development, genetics of floral organ differentiation, homeotic mutants in *Arabidopsis* and *Antirhinum*, sex determination.

Male gametophyte : Structure of anthers, microsporogenesis, role of tapetum, pollen development and gene expression, male sterility, sperm dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos.

Female gametophyte : Ovule development, megasporogeneis, organization of the embryo sac, structure of the embryo sac cells.

UNIT – IV

Pollination, pollen-pistil interaction and fertilization : Floral characteristics, pollination mechanisms and vectors, breeding systems, commercial considerations, structure of the pistil, pollen-stigma interactions, sporophytic and gametophytic self incompatibility (cytological, biochemical and molecular aspects), double fertilizatiom, in-vitro fertilization.

Seed development and food growth : Endosperm development during early maturation and desiccation stages, embryogenesis, ultra structure and nuclear cytology, cell lineages during late embryo development, storage proteins of endosperm and embryo, polyembryony, apomixis, embryo culture, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation.

UNIT – V

Latent life – dormancy : Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.

Senescence and programmed cell death (PCD) : Basic concepts, types of cell death, PCD in the life cycle of plants, metabolic changes associated with senescence and its regulation, influence of hormones and environmental factors of senescence.

Suggested Readings

1. Atwll, B.J. Kriedermann, P.E. and Jumbull, C.G.N. (eds). 1999. Plants in Action : Adaption in Nature Performance, in Cultivation, MacMillan Education. Sydney, Australia.
2. Bewley. J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press. New York.
3. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Deihi.
4. Burgess, J. 1985. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.
5. Fageri, K. and Van der Pijl, L. 1979. The Principle of Pollination Ecology. Pergamon Press, Oxford.
6. Fahn, A. 1982. Plant Anatomy. (3rd edition). Pergamon Press, Oxford.
7. Fosker, D.E. 1994. Plant Growth and Development. A Molecular Approach. Academic Press, San Diego.
8. Howell, S.H. 1998. Molecular Genetics of Plant Developmem. Cambridge University press, Cambridge.
9. Leins, P., TucKer, S.C. and Endress, P.K. 1988. Aspects of Floral Development, J. Cramer, Germany.
10. Lyndon, R.F. 1990. Plant Development. The Cellular Basis, Unnin Byman, London.
11. Murphy, T.M. and Thompson, W.E, 1988. Molecular Plant Development. Prentice Hall, New Jersey.
12. Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.
13. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
14. Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag, New York.
15. Raven, P.H., Evrt, R.F. and Eichhorn, S. 1992. Biology of Plants (5th edition). Worth, New York.

16. Salisbury, P.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing, Belmont, California.
17. Steeves, T.A. and Sussex, I.M., 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.
18. Sdgely, M. and Griffin, A.R. 1989. Sexual Reproduction to Tree Crops. Academic Press, London.
19. Waisel, Y., Eshel, A. and Kafkaki, U. (eds.). 1996. Plant Roots : The Hidden Hall (2nd edition). Marcel Dekker, New York.
20. Shivanna, K.R. and Sawhney, VK. (eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
21. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology : A Laboratory Manual. Springer-Verlag. Berlin.
22. Shivanna, K.R. and Johri, B.M. 19R5. The Angiosperm Polien : Structure and Function. Wiley Eastern Ltd.. New York.
23. The Plant Cell Special Issue on Reproductive Bilogy of Plants. Vol. 5(10) 1993. The American Society of Plant Physiologists, Rockville, Maryland. USA.

Suggested Laboratory/Field Exercises

1. Effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
2. Role of dark and red light/far-red light on the expansion of cotyledons and epicotylar hook opening in pea.
3. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
4. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe, tobacco*. Examination of shoot apices in a monocotyledon in both T.S.

and L.S. to show the origin and arrangement of leaf primordia.

5. Study of alternate and distichous, alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement. Examination of rosette plants (*Launaea, Mollugo, Raphanus, Hyoscyamus etc.*) and induction of bolting under natural conditions as well as by GA treatment.
6. Microscopic examination of vertical sections of leaves such as *Cannabis*, tobacco, *Nerium*, maize and wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C_3 and C_4 leaf anatomy of plants.
7. Study of epidermal peels of leaves such as *Coccinia, Gaillardia, Tradescantia, Notonea*. etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
8. Study of whole roots in monocots and dicots. Examinatian of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives. (use maize, aerial roots of banyan, *Pistia*, *Jussieua* etc.) Origin of lateral roots. Study of leguminous roots with different types of nodules.
9. Study of microsporogenesis and gametogenesis in sections of anthers.
10. Examinatian of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Crotoloria, Tradescantia, Brassica. Petunia, Solanum melongena*, etc.)
11. Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
12. Estimating percentage and average pollen tube length in vitro.

13. Role of transcription and translation inhibitors on pollen germination and pallen tube growth.
14. Pollen storage, pollen-pistil interaction, self-incompatibility, in vitro pollination.
15. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrasporic types of embryo sac development thorough examination of permanent, stained serial sections.
16. Field study of several types of flower with different pollination mechanisms (Wind pollination, **thrips** pollination, bee/butterfly pollination, bird pollination).
17. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate outcrossing systems. Study of cleistogamous flowers and their adaptations.
18. Study of nuclear and cellular endosperm through dissections and staining.
19. Isolalion of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
20. Study of seed dormancy and methods to break dormancy.

Suggested Readings. (for Laboratory Exercises)

1. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology : A Laboratory Mannual, Springer-Verlag, Berlin-Heidelberg (and references therein).
2. Chopra, V.L. 2001. Plant Breeding : Theory and Practice. Oxford IBH Pvt. Ltd., New Delhi.
3. Chopra, y.L. 2001. Plant Breeding: Field Crops. Oxford IBH Pvt. Ltd., New Delhi.

Paper VIII –Cell and Molecular Biology of Plants

Scheme of Examination

Duration : 3 hours **Max. Marks : 100**

Note : The question paper will contain three sections as under –

Section A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total Marks : 10

Section B : 10 question, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total Marks : 50

Section C : 4 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted. Total Marks : 40

Unit-I

The dynamic cell : Structural organization of the plant cell, specialized plant cell types, chemical foundation, biochemical energetics.

Cell wall : Structure and functions, biogenesis, growth.

Plasma membrane : Structure, models and functions, sites for ATPases, ion carriers, channels and pumps, receptors.

Plasmadesmata : Structure, role in movement of molecules and molecules, comparison with gap junctions.

Unit-II

Chloroplast : Structure, genome organization, gene expression, RNA editing, nucleochloroplastic interactions.

Mitochondria : Structure, genome organisation, biogeneris.

Plant vacuole : Tonoplant membrance, ATPase, transporters, as storage organelle.

Nucleus : Structure, nuclear pores, nucleosome organization, DNA structure, A, B and Z forms, replication, damage and repair, transcription, plant promoters and transcription factors, mRNA transport nucleolus,rRNA biosynthesis.

Unit-III

Restriction enzymes : Cleavage of DNA into specific fragments, construction of a restriction map from the fragments, restriction sites as genetic markers, RFLP and their use in plant breeding.

Ribosomes : Structure, site of protein synthesis, mechanism of translation, initiation, elongation and termination, structure and role of tRNA.

Unit-IV

Protein sorting : Targeting of proteins to organelles.

Cell shape and motility :The cytoskeleton, organization and role of microtubules and microfilaments, motor movements, implications in flagellar and other movements.

Cell cycle and apoptosis: Control mechanisms, role of cyclins and cyclin-dependent kinases, retinoblastoma and E2F proteins. Cytokinesis and cell plate formation, mechanisms of programmed cell.

Unit-V

Other Cellular organelles : Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum:

Techniques in cell biology : Immunotechniques, in situ hybridization to locate transcripts in cell types, FISH, GISH, confocal microscopy.

Suggested Readings :

1. Lewis, B. 2000 Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K and Watson, J., 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing USA.
4. Rost, T, etal. 1998. Plant Biology. Wadsworth Publishing Co., California USA.

5. Krishnamurthy, K.V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
6. Buchanan, B.B., Gruissem, W., and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists. Maryland, USA.
7. De, D.N. : 2000. Plant Cell Vacuoles : An Introduction. CSIRO Publication Collingwood, Australia.
8. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York USA.
9. Lodish, H., Berk, A. Zipursky, S.L. Matsudaira, P., Baltimore D. and Darnell, J. 2000. Molecular Cell Biology (4th Edition) W.H. Freeman and Co., New York, USA.

See the following Review Journals

Annual Review of Plant Physiology and Molecular Biology.
Current Advances in Plant Sciences.
Trends in Plant Sciences.
Nature Reviews : Molecular and Cell Biology.

Suggested laboratory Exercises

1. Isolation of mitochondria and the activity of its marker enzyme succinate dehydrogenase (SDH).
2. Isolation of chloroplasts and SDS-PAGE profile, of proteins demarcate the two subunits of Rubisco.
3. Isolation of nuclei and identification of histones by SDS-PAGE.
4. Isolation of plant DNA and its quantitation by spectrophotometric method.
5. Isolation of DNA. And preparation of 'cot' curve.
6. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
7. Isolation of RNA and quantitation by a spectrophotometric method.
8. Separation of plant RNA by agarose gel electrophoresis and visualization by EtBr staining.
9. Southern blot analysis using a gene specific probe.
10. Northern bolt analysis using a gene specific probe.
11. Immunological techniques : Ouchterlony method, ELISA and western blotting.
12. Fluorescence staining with FDA for cell viability and cell well staining with calcolflour.
13. Demonstration of SEM and TEM.

Note : Chemicals and kits for conducting some of the above molecular biology experiments are available in India, for example from M/s Bangalore Genei and Centre for Biotechnology (CSTR) Mall 'Road, Delhi.'

Suggested Reading (For laboratory exercises)

1. Glick, B.R. and Thompson, J.E. 1993, Methods in Plant Molecular, Biology and Biotechnology, CRC Press, Boca Raton, Florida.
2. Glover, D.M. and Hames, B.D. (Eds.), 1995. DNA Cloning 1: A Practical Approach, Core techniques. 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
3. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology : Structure and Function Jones and Bartlett Publishers, Boston, Massachusetts.
4. Hackett, P.B., Fuchs, J.A.and Messing, J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin Cummings Publishing Co.Inc. Menlo Park, California.
5. Hall, J.E. and Moore, A.L. 1983. Isolation of Membranes md Organelles from Plant Cells. Academic Press, London, U.K.
6. Harris, N and Oparka, K.J. 1994, Plant Cell Biology : A Practical Approach, IRL Press, at Oxford University Press, Oxford, U.K.
7. Shaw C.H. (Ed.), 1988. Plant Molecular Biology : A Practical Approach IRL press, Oxford.

Paper IX – Plant Resource Utilization and Conservation

Scheme of Examination **Duration : 3 hours** **Max. Marks : 100**

Note : The question paper will contain three sections as under –

Section A :	One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total Marks : 10
Section B :	10 question, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total Marks : 50
Section C :	4 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted. Total Marks : 40

UNIT – I

Plant Diversity : Concept, status in India, utilization and concerns.

Sustainable Development : Basic Concepts, origin of agriculture.

World Centers of primary diversity of domesticated plants : The Indo-Burmese center, plant introduction and secondary centers.

UNIT – II

Origin, evolution, botany, cultivation and uses of (i) Food, forage and fodder crops (ii) fiber crops (iii) medicinal and aromatic plants (iv) vegetable oil yielding crops.

Important firewood and timber yielding plants and non wood forest products (NWFPs) such as bamboos, rattans, raw materials for paper making, gums, tannins, dyes, resins and fruits.

UNIT – III

Green revolution : Benefits and adverse consequences, innovations for meeting world food demands.

Plants used as avenue trees for shade, pollution control and aesthetics : Principles of conservation, environmental status of plants based on IUCN.

UNIT – IV

Strategies for conservation – in situ conservation : International efforts and Indian initiatives, protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs conservation of wild biodiversity.

UNIT – V

Strategies for conservation – ex situ conservation : Principles and practices, botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBGPR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR) and the Department of Biotechnology (DBT) for conservation, non formal conservation efforts.

1. Anonymous 1997. National Gene Bank : Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
2. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No.-7.
3. Baker, H.G. 1978. Plants and Civilization (3rd edn.) C.A. Wadsworth, Belmont.
4. Bole, P.V. and Vaghani, Y. 1986. Field Guide to Common Indian Trees. Oxford University Press, Mumbai.
5. Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity in Medicinal and Aromatic Plans in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
6. Chrispeels, M.J. and Sadava, D. 1977. Plants, Food and People, W.H. Freeman and Co., San Francisco.
7. Cristi, B.R. (ed.) 1999. CRC Handbook of Plant Sciences and Agriculture. Vol. I. In-situ conservation. CRC Press, Boca Raton, Florida, USA.
8. Conway, G. 1999. The Doubly Green Revolution : Food for All in the 21st Century. Penguin Books.
9. Conway, G. and Barbier, E. 1990. After the Green Revolution. Earthscan Press, London.
10. Conway, G.and Barbief, E. 1994. Plant. Genes and Agriculture. Jones and Bartlett Publishers, Boston.
11. Council of Scienfific and Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.
12. Council of Scientific and Industrial Research (1948 - 1976). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (200).
13. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.

14. Directory of Indian Wetlands, 1993. WWF INDIA, New Delhi and AWB, Kuala Lumpur.
15. Falk, D.A., Olwel, M. and Millan C. 1996. Restoring Diversity, Island Press. Columbia, USA.
16. FAO/IBPGR 1989. Technical Guidelines for the Safe Movement of Germplasm. FAO/IBPGR, Rome.
17. Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The Conservation of Plant Diversity. Cambridge University Press, Cambridge, U.K.
18. Gadgil, M. and Guha, R. 1996. Ecology and Equity : Use and Abuse of Nature in Contemporary India. Penguin, New Delhi.
19. Gaston, K.J. (Ed.) Biodiversity : a Biology of Numbers and Differences. Blackwell Science Ltd., Oxford, U.K.
20. Heywood, V. (Ed). 1995 Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press, Cambridge, U.K.
21. Heywood, V.H, and Wyse lackn, P.S. (Eds) 1991. Tropical Botanical Gardens. Their Role in Conservation and Development. Academic Press, San Diego.
22. Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd edition. Macmillian India Ltd., Deihi.
23. Kothari, A. 1997. Understanding Biodiversity : Life Sustainability and Equity. Orient Longman.
24. Kohli, R., Arya, K.S., Singh, P.H. and Dhillon, H.S. 1994. Tree Directory of Chandigarh. Lovdale Educational, New Delhi.
25. Nair, M.N.B. et. al. (Eds.) 1988. Sustainable Management of Nonwood Forest Products. Faculty of Forestry, University Putra Malaysia. 43004 PM Serdong. Selangor, Malaysia.
26. Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Pubiication) South Asia Office, C/o NBPGR. Pusa Campus, New Delhi.

27. Pimentel, D. and Hall, C.W. (Eds.) 1989. Food and Natural Resources, Academic Press, London, New York.
28. Pinstrup-Anderson, P. et. al. 1999. World Food Prospects :Critical Issues for the Early 21st Century. International Food Policy Research Institute. Washington, D.C., USA.
29. Plant Wealth of India 1997. Special Issue of Proceedings Indian National Science Academy B-63.
30. Plucknett, D.L., Smith, N.J.H., William, J.T. and Murti Annishetty, N. 1987. Gene Banks and Worlds Food. Princeton Univrersity Press, Princeton, New Jersey, USA.
31. Rodgrs, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network in India. Vol. I. The Report. Wildlife Institute of India, Dehradun.
32. Sahni, K.C. 2900. The Book of Indian Trees. 2nd edition. Oxford University Press, Mumbai.
33. Schery, R.W. 1972. Plants for Man. 2nd ed. Englewood Cliffs, New Jersey. Prentice Hall.
34. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
35. Swaminathan, M.S. and Kocchar, S.L. (Eds.) 1989. Plants and Society. Macmillan Publication Ltd., London.
36. Thakur, R.S., Puri, H.S.and Husain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
37. Thomas, P. 2000. Trees: Their National History. Cambridge University Press, Cambridge.
38. Wanger, H., Hikino, H. and Farnswarth, N. 1989. Economic and Medicinal Plant Research. Vols. 1-3. Academic Press, London.
39. Walter, K.S. and Gillett, H.J. 1998. 1997 IUCN Red List of Threatened Plants. IUCN, the World Conservation Union. IUCN, Gland, Switzerland and Cambridge,U.K.

Suggested Laboratory Exercises The Practical course is divided into three units : (I) Laboratory work, (2) Field survey and (3) Scientific visits.

Laboratory Work

1. Food crops : Wheat, rice, maize, chickpea (Bengal gram), potato, tapioca, sweet potato, sugarcane. Morphology, anatomy, microchemical tests for stored food materials.
2. Forage/fodder crops : Study of any five important crops of the locality (for example fodder sorghum, bajra, berseem, clove, guar bean, gram, Ficus sp.)
3. Plant fibers :
   (a) Textile fibres : cotton, jute, linen, sunn hemp, *Cannabis*.
   (b) Cordage fibres : coir
   (c) Fibres for stuffing : silk cotton or kapok
   Morphology, anatomy, (microscopic) study of whole fibres using -appropriate staining procedures.
4. Medicinal and aromatic plants : Depending on the geographical location college/university select five medicinal and aromatic plants each from a garden crop field (or from the wild only if they are abundantly available).

   Papaver somniferum, Atropa belladonna, Catharanthus roseus, Adhatoda cylanica (syn A. vasica) Allium sativum, Rauwolffia serpentina, Withania somnifera, Phyllanthus amarus, (P. fratermus), Andrographis paniculata, Aloe barbadens, Mentha arvensis, Rosa sp., Pogostemon cablin, Origanum vulgare, Vetiveria zizanioides. Jasminum grandiflorum, Cymbopogon sp., Pandanus odoratissimus.

   Study of live or herbarium specimens or other visual materials. to become familiar with these resources.

5. Vegetaible oils : Mustard, groundnut, soybean, coconut, sunflower, castor, Morphology, microscopic structure of the oil-yielding tissues, tests for oil and iodine number.

6. Gums, resins, tannins, dyes : Perform simple tests for gums and resins. Prepare a water extract of vegetable tannins *(Acacia, Terminalia, mangroves, tea, Cassia spp., myrobalans)* and dyes (turmeric, *Bixa orellana*, indigo, *Butea monosperma, Lawsonia inermis*) and perform tests to understand their chemical nature.

Field Survey

7. **Firewood and timber yielding plants and NWF's :**
   a. Prepare a short list of 10 most important sources of firewood and timber in your locality. Give their local names, scientific names, and families to which they belong. Mention, their properties.
   b. Prepare an inventory of the bamboos and rattans of your area giving their scientific and local names and their various uses with aprropriate illustrations.
   c. A survey of a part of the town or city should be carried out by the entire class, In batches. Individual students will select one avenue/road and locate the trees planted on a graph paper. They will identify the trees, mention their size, canopy shape, blossoming and fruiting period and their status (healthy, diseased, infested, mutilated, misused or dying) and report whether or not the conditions in which they are surviving are satisfactory. The individual reports will be combined to prepare a larger map of the area, which can be used for subsequent monitoring either by the next batch of students/teachers/local communities/NGOs/ or civic authorities. The purpose of exercise in item C above is to make the students aware of the kinds of trees and value in urban ecosystems and ecological services.

Scientific Visits*

The students should be taken to one of the following :

i. A protected area (biosphere reserve, national park, or a sanctuary)
ii. A wetland
iii. A mangrove
iv. National Bureau of Plant Genetic Resources, New Delhi-110012 or one of its field stations.
v. Head Quarters of the Botanical Survey of India or one of its Regional Circles.
vi. A CSIR Laboratory doing research on plants and their utilization.
vii. An ICAR Research Institute or a field station dealing with one major crop or crops.
viii. A recognised botnical graden or a museum (such as those at the Forest Research Institute, dehradun, National Botanical Institute, Lucknow, Tropical Botanical Garden and Reaserch Institute, Trivendram), which has collection of planrt products.

Note : The students are expected to prepare a brief illustrated narrative of the field survey and scientific Visits. After evaluation, the grades awarded to the students by the teachers should be added to the field assessment of the practical examination.

Paper X – Biotechnology, Genetic Engineering, Plant Breeding and Biometry

Scheme of Examination **Duration : 3 hours** **Max. Marks : 100**

Note : The question paper will contain three sections as under –

Section A :	One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.	Total Marks : 10
Section B :	10 question, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.	Total Marks : 50
Section C :	4 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted.	Total Marks : 40

UNIT – I

Biotechnology : Concepts and scope of biotechnology, plant tissue culture, anther and pollen culture, callus culture and protoplast culture.

Isolation, purification, culture and fusion, cybrids and hybrids, biotransformation, production of useful compounds through cell culture, vectors, plasmids and cosmids, cloning strategies, basic concept about cDNA, gene and genomic library, applications of rDNA technology, genetic

engineering and its principles, gene transfer, transgenic plants, methods, production, application and use and importance of genetic engineering, Cryopreservation.

UNIT – II

Genetic Engineering of plants : Aims and strategies for development of transgenics, *Agrobacterium* – the natural genetic engineer, T-DNA and transposon mediated gene tagging, chloroplast transformation and its utility, intellectual property rights, possible ecological risks and ethical concerns.

Microbial genetic manipulation : Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology.

UNIT – III

Genomics and Proteomics : Genetic and physical mapping of genes, molecular markers for introgression of useful traits, artificial chromosomes, high throughput sequencing, genome projects, bioinformatics, functional genomics, microarrays, protein profiling and its significance.

Bioactive compounds : Alkaloids, antioxidants, flavanoids, proteins and terpenoids.

UNIT – IV

Plant Breeding : Introduction, breeding methods in self and cross pollinated and vegetatively propagated crops, polyploidy and mutations and their uses in breeding, characterization of polyploids and mutants, Heterosis and inbreeding depression and causes of hybrid vigour, production and application of hybrid vigour in plant breeding.

UNIT – V

Biometry : Mean, mode and median, standard deviation and standard error, experimental errors, hypothesis testing, reliability and validity of results and inferences from experiments, variance, coefficient of variance, probability distribution, positive and negative bionomial, chi square test hypothesis, simple correlations.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture : Theory and Practice (a revised edition). Elsevier Science Publishers, New York. USA.
2. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations : Elsevier Science Publishers, New York, USA.
3. Brown, T.A. 1999. Genomes. John Wiley & Sons (Asia) Pvt. Ltd. Singapore.
4. Callow, J.A., Ford-Lioyd, B.V. and Newbury, H.J. 1997. Biotechnology and Plant Genetic Resources : Conservation and Use. CAB International, Oxon, UK.
5. Chrispeels, M.J. and Sadava, D.E. 1994. Plants. Genes and Agriculture. Jones & Bartlett Publishers, Boston, USA.
6. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
7. Glazer, A.N. and Nikaido, H. 1995. Microbial Biotechnology. W.H. Freeman & Company, New York, USA.
8. Gustafson, J.P. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.
9. Henry, R.J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall; London, UK.
10. Jain, S.M., Sopory, S.K. and Veilleux, R.E. 1996. in vitro Haploid Production in Higher Plants, Vols. 1-5,

Fundamental Aspects and Methods, Kluwer Academic Publishers, Dordrecht. The Netherlands.
11. Jolles, O. and Jornvall, H. (eds.) 2000. Protemics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
12. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.
13. Old, R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation : Blackwell Scientific Publications, Oxford, UK.
14. Primrose, S.B. 1995. Principles of Genome Analysis : Blackwell Science Ltd., Oxford, UK.
15. Raghavan, V. 1986. Embryogenesis in Angiosperms : A Developmental and Experimental Study. Cambridge University Press, New York, USA.
16. Raghavan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press, NewYork, USA.
17. Shantharam, S. and Montgomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
18. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands.

Suggested Laboratory Exercises

1. Growth characteristics of *E. coli* using plating and turbidimetric methods.
2. Isolation of plasmid from *E. coli* by alkaline lysis method and its quantitation spectrophotometrically.
3. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
4. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and selection of recombinants.

5. Demonstration of DNA sequencing by Sanger's di-deoxy method.
6. Isolation of protoplasts from various plant tissues and testing their viability.
7. Effect of physical (e.g. temperature) and chemical (e.g. osmoticum) factors on protoplast yield.
8. Demonstration of protoplast fusion employing PEG.
9. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
10. Demonstration of androgenesis in Datura.
11. Electroporation of protoplasts and checking of transient expression of the reporter gene.
12. Co-cultivation of the plant material (e.g. leaf discs) with Agrobacterium and study GUS activity histochemically.

Suggested Reading (for Laboratory Exercises)

1. Butenko, R.G. 2000. Plant Cell Culture, University Press of Pacific.
2. Collin, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
3. Dixon, R.A. (Ed.) 1987. Plant Cell Culture :Practical Approach. IRL Press, Oxford.
4. Gelvin, S.B. and Schilperoort, R.A. (eds.) 1994. Planl Molecular Biology Manual. 2nd edition, Kluwer Academic Publishers, Dordrecht. The Netherlands.
5. George, E.F. 1993. Plant Propagation by Tissue Culture. Part 1. The Technology, 2nd edition. Exegetics Ltd., Edington, UK.
6. George, E.F. 1993. Plant Propagation by Tissue Culture. Part 2. In Practice 2nd edition. Exegetics Ltd., Edington, UK.
7. Glick B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnolgy. CRC Press, Boca Raton, Florida.

8. Glover, D.M. and Hames, B.D. (Eds.) 1995. DNA Cloning 1 : A Practical Approach, Core Techniques, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
9. Hackett, P.B., Fuchs, J.A. and Meesing, J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co., Inc. Menlo Park, California.
10. Hall, R.D. (Ed.) 1999. Plant Cell Culture Protocols. Humana Press, Inc., New Jersey, USA.
11. Shaw, C.H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach, IRL Press, Oxford.
12. Smith, R.H. 2000. Plant Tissue Culture: Techniques and Experiments. academic press, New York.

Paper XI (a)
Advanced Plant Pathology -I

3 Hrs. Duration 100 Marks

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total marks : 10

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total marks : 50

Section-C : 04 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted.Total marks : 40

Unit I

Principles : History of plant pathology; The nature, origin and evolution of parasitism.

Interaction of pathogen, soil, other soil microorganism and the host, Biotrophic parasites in culture, Role of plant tissue culture in studies on host – parasite relationships.

Phenomenon of plant infection, penetration, infection, post infection development, factors affecting infection, defense mechanisms.

Unit II

Host pathogen interaction: The response of the host, pathogenecity and virulence, host specific toxins in relation to pathogenesis and disease resistance.

Nucleic acids in host parasitics and disease forecasting.

Plant disease control: Physical control, chemical control, plant quarantines, plant disease resistance and breeding of resistance varieties.

Methods : Techniques of isolation, purification, culture and inoculation of pathogens.Technique of tissue culture and its applications in plant pathology.Raising virus free plants in culture.

Unit III

Testing of efficacy of fungicides.

Fungal diseases: Symptomatology and disease identification,

Some important diseases of cereals: Smuts, rusts, leaf blights, spots, mildews, karnal burnt and flag smut of wheat; covered smut and stripe disease of barley. Brown spot and blast of paddy, Brown spot, downy mildews and Drechlera (Helminthosporium) blights of Maize; ergot and smut of Bajra, leafspots and smuts of jowar, green ear disease of Bajra.

Unit IV

Other Diseases : Red rot and smut of sugarcane; Fusarium wilt of cotton, flax and pigeon pea; flax rust; Asochyta blight of gram; early blight of tomato and potato; late blight of potato; Tikka disease of groundnut and downy and powdery mildews of grapes.

Unit V

Histopathology, calibration of microscopes and measurements. Knowledge of electron microscope in histopathological investigations. Writing for publication, literature collection and consultation, notes on experiments, photographs and illustrations (camera lucida drawings), writing and galley proofing of manuscripts.

Note: Practicals based on theory syllabus.

Paper XII (a)
Advanced Plant Pathology – II

3 Hrs. Duration 100 Marks

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total marks : 10

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total marks : 50

Section-C : 04 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted.Total marks : 40

Unit I

Classification and nomenclature of bacterial pathogens. Symptomatology
Methods of identification of bacterial pathogens:morphology, physiology, serology and pathogenecity;
Physiological and cytological aspects of bacterial infection process and disease development, mechanism of infection of bacterial pathogens.

Unit II

Bacterial disease: Brown rot, ring rot of potato, fire blight of stone fruits, tundu disease of wheat, stalk rot of Maize;
Bacterial blight of rice, soft rot of vegetables; red strip of sugarcane; crown gall disease ;
Angular leaf spot of cotton, citrus canker.

Unit III

Virology: Classification, morphology, physiology and nature of viruses; Symptomatology, isolation, purification and culturing of viruses;
Viral infection, nutrition , synthesis and mutation;
Transmission of viral diseases, Mycoplasma;
Acquired immunity, interference and synergism;
Viral diseases: Potato virus X and Y; Potato yellow dwarf; Tomato mosaic and tomato ring mosaic; Tobacco necrosis; Cucumber mosaic; Bunchy top of banana; Bhindi yellow mosaic.

Unit IV

Nematology: Classification and identification of plant pathogenic nematodes; Morphology and anatomy of nematodes;
Methods used in nematology;
Nematode disease: Ear cockle of wheat; Root knot of vegetables; Molya disease of wheat.
Non parasitic diseases : Diseases due to deficiency of Nitrogen, Zinc, Boron, oxygen, Preliminary studies on diseases due to excess of Ozone; PAN (Peroxyacyl nitrate), Sulfur di oxide, sulphur and Hydrogen fluoride in atmosphere, soil and water.

Unit V

Cecidology: Classification and anatomy of galls. Some insect induced plant galls of Rajasthan (Pongamia leaf galls, Cordia leaf galls, Zyziphus stem galls, Prosopis stem galls), mechanism and physiology of insect galls.

Note : Practicals based on theory syllabus.

Paper XI (b) – Environmental Biology

Scheme of Examination

Duration : 3 hours **Max. Marks : 100**

Note : The question paper will contain three sections as under –

Section A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total Marks : 10

Section B : 10 question, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total Marks : 50

Section C : 4 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted. Total Marks : 40

UNIT – I

Ecosystem : Concept, structure and function of Grassland, forest, fresh water and Marine ecosystems, biogeochemical cycles, evolution of ecosystem, ecological energetic and flow of energy.

UNIT – II

Natural Resources: water, soil, energy and wild life management and their remediation, biodiversity conservation, sanctuaries, national parks, non-conventional energy sources, solar, wind, tidal and geothermal energy sources, 3 R's (Reduction, Recycle & Reuse).

UNIT – III

Air, water and soil pollution, types of pollutants – their sources and impact on humans, plants and animals. Noise, Land, radiation and thermal pollution – Sources and characteristics. Global Warming, ozone depletion and acid rains. Ganga Action Plan, Ecoleveling and Environmental Auditing, water pollution (Prevention and control of Pollution Act 1974). Air Pollution Act.

UNIT – IV

Consequences of growing human population on environment. Ecosystems : Man made ecosystems – Urban and rural. Environmental Impact Assessment (EIA), Social Impact Assessment (SIA) and sustainable development. Solid Waste Management.

UNIT – V

Environmental education and awareness : Environmental laws & Ethics: Wild Life Protection Act 1972. Poaching and killing of wild life. Forest conservation Act 1980, ecofeminism, Social forestry and role of tribals in conservation, environmental economics – issues in perspective global economy, ecopolitics and green policies.

Note: Practicals based on theory syllabus.

Paper XII (b) – Arid Zone Ecology

Scheme of Examination Duration : 3 hours

Max. Marks : 100

Note : The question paper will contain three sections as under –

Section A :	One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. Total Marks : 10
Section B :	10 question, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words. Total Marks : 50
Section C :	4 questions (question may have sub division) covering all units descriptive type, answer in about 500 words, 2 questions to be attempted. Total Marks :40

UNIT – I

Deserts : their formation, topography and distribution, characteristics of deserts with special reference to water economy. The hot and cold deserts and other similar habitats, Arid regions of India with particular reference to Thar desert in Rajasthan.

UNIT – II

Rajasthan - Geology, physiography, climate, vegetations & plant communities of deserts and soil. Saline tracts and their vegetation (Halophytes), Mangrove vegetation, Sand Dunes – classification, stabilization and management

UNIT – III

Adaptation of plants and animals to arid conditions, Biotic factors including the role of man on the vegetation and fauna in arid zones, Types and distribution of wastelands in India

UNIT – IV

Habit studies and phenology of desert plants through various seasons, root investigation, reproductive capacity, seed output, germination, dormancy and viability, perennation.

UNIT – V

Desert as an ecosystem, biological productivity, cycles and balances in the desert ecosystems, wind break and shelter belts, Indira Gandhi Canal and its ecological implications, dry land farming, underground water resources.

Note: Practicals based on theory syllabus.

Skeleton Paper

M.Sc. (F) Practical Examination
Special Paper – Advance Ecology XI and XII (b)

Time : 4 hrs **M.M.: 100**

Q.No.		Marks Alloted
1.	Determine organic matter content of the given soil sample by Walkely & Black method. **Or** Determine the dissolved O_2 in a given water body by Winkler iodometric method.	25
2.	Prepare the glycerin mount of the given plant materials explaining their anatomical adaptations in relation to habitat. **Or** Study the various types of trichomes and their rolling mechanism to withstand during drought of given plant material.	25
3.	Determine the total hardness Co_2 /$Cl^-$of the given water sample.	10
4.	Determine pH of the given soil sample by pH meter. **Or** Determine the conductivity of the given soil sample.	05
5.	Comment upon the spots (1-5)	10
6.	Practical Record	15
7.	Viva-Voce	10

Skeleton Paper

M.Sc. (F) Papers VII, VIII, IX & X
Practical Examination
First Day (4 Hrs)

VII – Plant Development & Reproduction
IX – Plant Resources Utilisation and Conservation

Q.No.			Mark Allotted
1.	(a)	Make suitable preparation of the given material. Draw labeled diagram, and study the anatomical features with special reference to its vascular structure. Discuss points of special interest.	16
	(b)	With the help of suitable preparation study the floral / seedcoat / epidermal / micro-sporangium wall structure of the material provided. Draw labeled diagram and comment upon its features.	16
2.	(a)	Identify any two ….. materials from the given samples. Give economic importance with special reference to origin, cultivation, part used and processing , if any.	16
	(b)	Mark the highest yield producing areas in the map provided to you.	15
3.		Spots 1-4	12

M.Sc. (F) Papers VII, VIII, IX & X
Practical Examination
Second Day (4 Hrs)

X – Cell and Molecular Biologee of Plants
XI – Biotechnology and Genetic Engineering of Plants & Microbes.

Q.No.			Mark Alloted
4.	(a)	Perform the given molecular biologee exercise.	16
	(b)	Perform the given cell biologee exercise.	16
5.	(a)	Perform biotechnological exercise given to you.	16
	(b)	Write details for the exercise given to you.	15
6.		Sports 1 to 4	12
7.		Records / Sessionals / Project	30
8.		Viva-Voce	20

M.Sc. (F)
Practical Examination
Second Day (4 Hrs)
Advance Plant Pathology (Paper- XI-A & XII-A)

Q.No.	Questions	Mark Allotted
1.	Study the histapathology of the material 'A'. Make suitable preparation of the given material. Assign symptoms, causal organism and identify the disease making pathological note of the given material.	15
2.	Calibrate your microscope. Find out the average size of the fungal spore given to you.	
	OR	
	Draw the camera-lucida drawing of the given material.	
3.	Study the given material 'B" write symptoms and etiology of the disease	05
4.	Make a comparative phyto-pathological note on the material 'C' and 'B'	10
5.	Study the histopathology of the material "E" Write points of special interest.	10
6.	Prepare a Bacterial preparation of the given material "F" using Gram Staining. Write and conclude about the results.	10
7.	Comment up on the 1 to 5	10
8.	Viva-Voce	10
9.	Records	15